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Impact of the Size of the Hearing Aid on the Mobile Phone Near Fields

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Abstract— The near fields are the main factors defining the level of interaction between the mobile phones and the hearing aids which up to now has been evaluated through the hearing aids compatibility (HAC) standard in free space. However, in real life situation both the user and the hearing device will change the fields significantly. In this paper, we have investigated the influence of the size of the in-the-canal hearing aid on the electric near fields for folded J antenna (FJA) and planar inverted F antenna (PIFA) fitting into a mobile phone with candy bar form factor. The user's influence has been represented with the use of the Visible Human Project (VHP) phantom head.

1. INTRODUCTION

When a hearing impaired person uses a hearing aid and a digital mobile phone, due to the fact that the hearing device is located in the near field of the mobile phone's antenna, the user is exposed to a buzzing noise in the hearing device caused by the interference from the mobile phone. The result is annoying effect on the user and a negative influence on the intelligibility of the speech [1, 2]. Some efforts have been focused on measurements, modeling and evaluation of the interference [3–5]. As a result of the collaboration between the hearing aid industry and mobile phone manufacturers, the American National Standards Institute has formed a working group which has developed a standard for hearing aids compatibility (HAC), its most recent version is from 2007 [6]. A comparison between free space and with the impact of the head has been carried out to see how well the standard reflects the real case in [7]. A comprehensive study of the near fields for typical antennas in mobile handsets which investigates the fundamental theoretical issues does not exist in the open literature. The task gets even more complicated because of the variety of the hearing aids available on the market which would complicate additionally the evaluation of the near fields and the HAC of the mobile phones.

In this article, we investigate the influence of the presence of human head, hearing aid, and its size on the near fields of the mobile phones. The folded J antennas (FJA) and planar inverted F antennas (PIFA) serve as radiators mounted in a form factor corresponding to a typical candy bar mobile phone. Numerical study has been carried out using the finite-difference time-domain (FDTD) method [8] in the low band (850 MHz) and high band (1900 MHz) GSM frequency ranges. The FDTD method has been proved to be an efficient technique for solving complex electromagnetic problems [9].

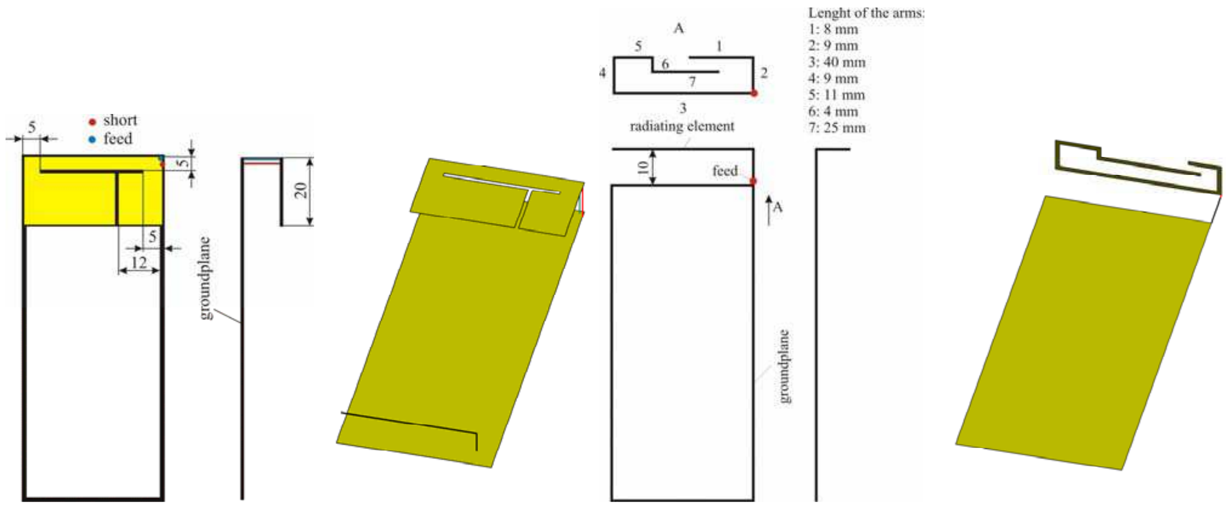
2. ANTENNA CONFIGURATION

The antenna configurations are shown in Figure 1 and the 3-D view of the numerical model for the simulation with the VHP phantom head is shown in Figure 2. The antennas cover the 850 MHz and 1900 MHz GSM frequency bands. The mobile phone is positioned horizontally with respect to the phantom head. The hearing aid is modeled as perfect electric conductor box with initial dimensions $5 \times 5 \times 5$ mm. Both antennas fit into a candy bar mobile phone with dimensions $40 \times 100 \times 10$ mm (width $\times$ length $\times$ thickness).

3. NUMERICAL RESULTS

The peak electric fields for both types of antennas are shown in Figure 2 and Figure 3. As expected, the peak electric fields are increased when the hearing aid is present in the models. However, the increase is not very significant for the FJA antenna at the low band.

When varying the dimensions of the hearing aid, the y dimension does not influence the peak electric field, because it is lateral with respect to both antennas. As both of the antennas have vertically polarized feed, the influence is expected to be larger when increasing the x dimension and that is indeed the case. Increasing the z dimension then shifts the field response away from the



(a) (b)

Figure 1: Dual-band PIFA antenna (a) and FJA antenna (b).

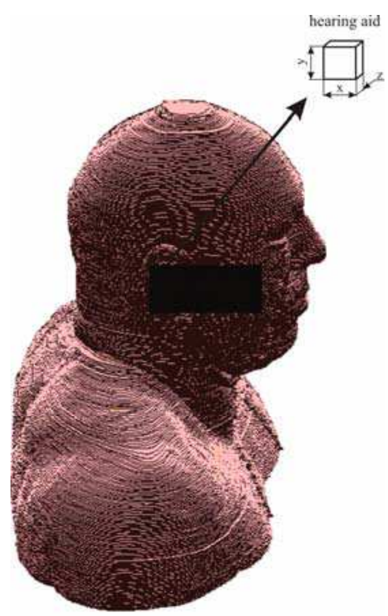
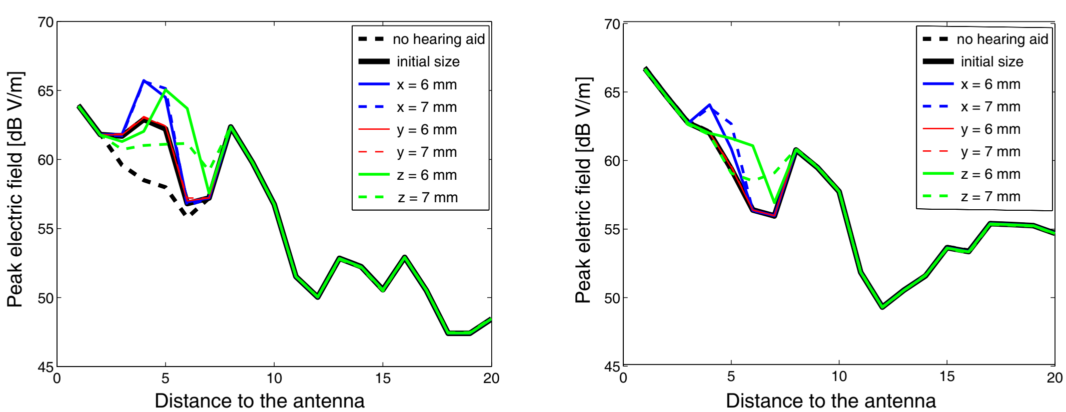
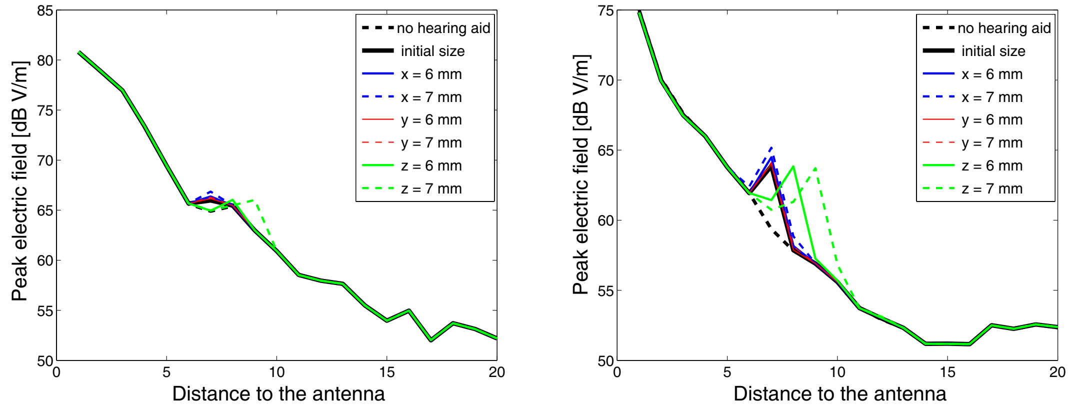


Figure 2: 3-D view of the numerical model with the VHP phantom head included.



(a) (b)

Figure 3: Peak electric field of PIFA at low band (a) and high band (b).



(a) (b)

Figure 4: Peak electric field of FJA at low band (a) and high band (b).

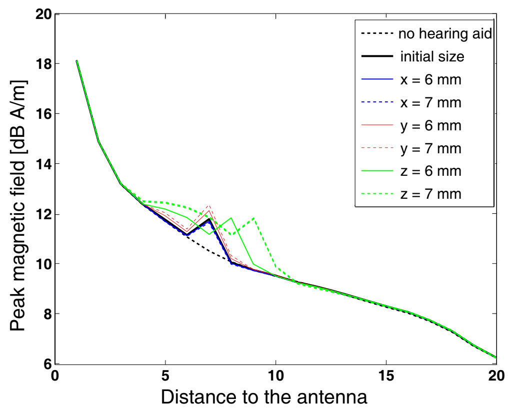


Figure 5: Peak magnetic field of FJA at low band.

antenna. Figure 4 shows the peak magnetic fields of the FJA antenna at low band, for comparison. Here the increase of the field occurs with varying every dimension of the hearing aid, the y dimension included.

4. CONCLUSIONS

Investigation of the impact of the hearing aid and its size on the electric and magnetic fields generated by FJA and PIFA antennas has been performed. It has been found that the hearing aid itself caused an increase in the peak electric field up to 5 dB V/m. This clearly demonstrates that the current HAC standard which is based on field values in free space may be inaccurate. Therefore, in the future HAC standard the influence of the hearing aids needs to be taken into an account.

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